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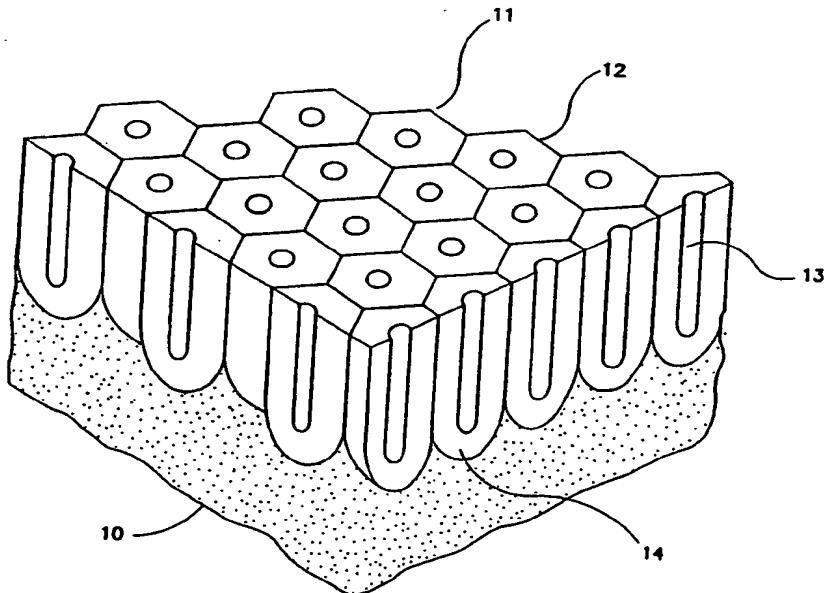
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(54) Title: METAL TREATMENT



(57) Abstract

Seal coating compositions and method of applying same, to metallic surfaces, particularly aluminum or alloys thereof, containing a previously formed protective coating on the metal surface, to provide for improved corrosion resistance beyond that provided by the previously formed protective coating. Aqueous solutions of the seal coating components are applied to the metal surface containing the previously formed coating which is subsequently rinsed and dried to provide metal articles having improved resistance to corrosion.

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METAL TREATMENT

BACKGROUND OF THE INVENTIONField of the Invention

5 This invention relates to the field of protective and/or surface treatment of articles, particularly metal surfaces and to surface treatment compositions employed as solutions or dispersions and methods of using these compositions. The compositions coated on the metal surfaces provide improved corrosion resistance and adhesion of any subsequent overlaying coatings.

10 Statement of Related Art

15 In the art of treating metal surfaces, it is common practice to improve the corrosion resistance characteristics and bonding of subsequent coatings to the metal surface by depositing or coating the metal surface with a protective coating or film. In order to improve the qualities of the already applied protective coating, it is common to provide a second or subsequent coating after the initial protective coating has been formed on the metal surface. This second coating further enhances the corrosion resistance of the unpainted metal surface and to prepare the surface for reception of a final finish

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coating where one is to be employed, such as a paint, enamel or lacquer. In U.S. Patent 3,912,548, assigned to Amchem Products, Inc., there is described an aqueous zirconium compound-polyacrylic acid coating composition which is applied to a metal surface already having deposited thereon a conversion coating, which results from treatment of a base metal surface with aqueous solutions which react with the metal surface. The conversion coatings described in the patent are chromate or phosphate coating.

Conversion coatings which include hexavalent chromium have been widely used in the past to protect metals such as iron, zinc, magnesium and aluminum or alloys of aluminum including those with manganese, copper, zinc, silicon and magnesium. While such chromium coatings provide good corrosion resistance properties, recent attempts have been made to produce acceptable chromate-free coatings because of growing concern regarding pollution effects of the chromate and phosphate, particularly hexavalent chromium, discharged into rivers and waterways, which results in extensive waste treatment procedures being required to control their discharge. In U.S. Patent 3,964,936, assigned to Amchem Products, Inc., there is reported and described various attempts to develop chromium-free aluminum coating solutions and describes a zirconium coating solution, which may also include boric acid. In describing coating solutions Examples 29 and 30 in the patent, which include sodium nitrate and cobalt nitrate, $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, reference is made also to U.S. Patent 3,682,713, which includes a sodium nitrite component in a coating solution for steel and galvanized steel as well as aluminum.

U.S. Patents 4,963,596 and 4,970,264 assigned to Henkel Corporation, describe the use of modified polyphenol compounds, which may be used in the "post-treatment" of conversion coated metal surfaces.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is an enlarged view of one species, a cell and pore structure, of metal coating which may be improved further by the compositions of the present invention.

5 DESCRIPTION OF THE INVENTION

In this description, except in the working examples and claims, and wherever expressly indicated to the contrary, all numerical specifications of amounts of materials, or conditions of reaction or use, are to be understood as modified by the term "about" in describing the broadest scope of the invention. Practice of the invention within the exact numerical limits is however, generally preferred.

15 The present invention provides for compositions, solutions and dispersions, and methods for use in treatment of metal surfaces already having a protective coating or film thereon. The compositions of the present invention accordingly deal with a post-treatment or secondary coating to further improve the corrosion 20 resistance of the metal surface and to provide or retain adhesion properties for application of other coatings, where desired, such as paints, enamels, lacquers or other protective or decorative coatings. This secondary coating acts to seal the already applied protective coating on the 25 metal surface.

30 The metal surfaces which may be treated in accordance with the present invention may be any metal surface, including iron, zinc, magnesium, steel metal surfaces, including galvanized steel, aluminum or alloys thereof with metals such as copper, zinc, manganese, silicon and magnesium.

35 Virtually any metal surface, containing a protective or decorative coating or film thereon, may be treated by the seal coatings and compositions of the present invention. The invention is thus directed to an overlay composition to seal the initial coating on the metal surface, which initial coating or film may be of any type.

The invention is thus applicable to conversion coatings, such as the chromate and/or phosphate coatings employed on aluminum or aluminum alloys or the more recently developed chromate-free coatings such as those of U.S. Patent 5 3,964,936 discussed earlier. The invention is not only applicable to conversion coatings, but also any coating or film, smooth or porous, which may be improved by the overlay coating or film of the present invention, including anodic or anodized aluminum or magnesium 10 coatings, which are then sealed or coated by composition of the present invention. The invention is particularly applicable to seal coatings of a tubular pore or cell structure, such as those shown in Figure 1, in which a metal surface 10, such as aluminum, has a coating formed 15 of a tubular porous structure 11 having hexagonal shape cells 12, extending upward from the metal surface with pores 13 extending into the cells, the lower levels of the cells forming a barrier layer 14 at the interface of the metal and the coating or film. Such a structure as shown 20 in Figure 1 having a hexagonal shaped cell or wall structure, resembling a bee hive cell structure, is found in anodized aluminum coatings. With other coatings, non- 25 conversion coatings, similar structures may result in the formation of the coating with a tubular pore structure extending upwardly from the metal surface, in which the shape of the tubular structure may, instead of hexagonal, be circular, oval, triangular, square, rectangular, diamond shape or other configuration, which contain pores extending downwardly. The coating compositions of the 30 present invention are particularly effective in sealing such tubular pore structures, the compositions extending into the pores, with the penetration and depth into the core determining the effectiveness of the seal coating.

It is accordingly clear that the coating or sealing 35 compositions of the present invention may be applied to any protective coated metal surface or article to improve the corrosion resistance or protective properties and to

improve adhesion of other overlying protective or decorative coatings, such as paints, etc. mentioned earlier, where such are desired.

The initial protective coated metal surface or article, which is then treated in accordance with the present invention, is prepared in the conventional manner known to those in the art, either by (a) conversion-coating techniques, chromate and phosphate or chromate-free conversion coatings, (b) anodized coatings of aluminum or magnesium oxides, or (c) other continuous film, smooth or porous coatings. In general, conversion coatings which react with the metal surface, or non-conversion coatings, which are not reactive with the metal surface, but which may form a layer or film coating adhered to the metal surface, are formed by cleaning the metal surface with an acid or alkaline cleaning (which are readily available commercially) and deoxidized, if necessary, followed by a water rinse and application of the protective coating composition, which is applied in the usual, conventional manner for the particular metallic article. Such application methods will include, immersion, spray coating, roller coating, flow-coating, and the like. After the coating solution has been applied to the metal surface, it is generally rinsed with water, preferably including a deionized water rinse after which the coated article is dried, conveniently in an oven having forced circulation of hot air typically at temperatures up to 450°F for metals generally with temperatures of up to about 200°F preferred for aluminum and similar metals. Other available drying methods can be used, including air drying at ambient temperatures, usually about 20-23°C.

The protective coated metal article is then treated in accordance with the present invention, with the coating composition described in more detail below, applied in the manner described to provide metal articles having improved corrosion resistance and providing enhanced adhesion

properties.

The treating compositions of the present invention to provide a seal coating overlaying the initial protective coating of the metal surface are of various types, with the particular type to be employed, generally dependent on the particular metal surface or article and type of initial coating, i.e. anodized, conversion, non-conversion, tubular pore structure and the like. The compositions are particularly useful in relation to aluminum substrates, which is used in the aerospace industry, auto industry and in cans and house sidings, and any application where corrosion resistance and adhesion properties are required.

The seal coating compositions of the present include inorganic and organic coating compositions which are employed in a liquid, generally aqueous composition in which the components are dissolved in water, and are formulated so as to contain in the working solution form, either as an immersion or dipping bath, or as a spray or other coating form, from about 25-5000 ppm, preferably 500-2000 ppm of the active coating components or ingredients.

Inorganic compositions are mixtures of nickel sulfate, manganese sulfate or cobalt nitrate, boric acid and ammonium nitrate. The preferred inorganic compositions have the following formulations:

	<u>Formula</u>	<u>Components</u>	<u>grams/liter (g/l)</u>
	(a)	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	8
		$\text{MnSO}_4 \cdot \text{H}_2\text{O}$	8
30		H_3BO_3	20
		NH_4NO_3	16
	(b)	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	8
		$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	8
		H_3BO_3	20
35		NH_4NO_3	16

In the formulations above, the total amount of the nickel sulfate and manganese sulfate, and similarly of the nickel sulfate and cobalt nitrate in formulation (b) is at a level of 16 grams/liter. The amount may however vary from about 12-20 g/l. In addition the ratios of these components by weight in the preferred compositions are 5 1:1. The ratio of the nickel sulfate to the manganese sulfate in formulation (a) or to the cobalt nitrate in formulation (b) may vary however from 1:5 to 5:1. In some 10 cases it may be desirable to replace the nickel sulfate completely with the manganese sulfate or the cobalt nitrate.

Further, while the preferred composition employs boric acid H_3BO_3 , it is to be understood that the borates, 15 ammonium or alkali metal borates, such as sodium and potassium may be employed, either as a full or partial replacement for the acid. While other borates may also be employed, the acid is preferred and the ammonium or alkali metal borates are more desirable than others. The boric acid content in the formulations may also be varied from about 15-25 g/l. It is preferred that the amount of boric acid employed be in an amount by weight substantial equal to or in slight excess (up to about 20%) of the amount of ammonium nitrate employed and to the mixture of nickel and 20 manganese sulfate or mixture of nickel sulfate and cobalt nitrate. The ammonium nitrate may vary also from about 25 10-30 g/l.

An organic coating formulation preferred is an aqueous solution of an azole, either aromatic or aliphatic. The 30 preferred azoles are the triazole compounds containing up to 18 carbon atoms, such as alkyl and aryl triazoles. The preferred aryl triazoles are those containing about 6-10 carbon atoms, including benzotriazole and tolyltriazole, and preferred alkyl triazoles are those containing 1-6 35 carbon atoms, such as methyl triazole. Such triazoles are commercially available from PMC Specialty Group, Inc., Cincinnati, Ohio under the tradename "COBRATEC", such as

COBRATEC 700, 725, 99 or TT-100. The benzotriazol (COBRATEC 99), CAS No. 95-14-7 is available as an off-white to light yellow flake and tolyltriazole (COBRATEC TT-100), CAS #29385-43-1 is available as tan to light brown granules.

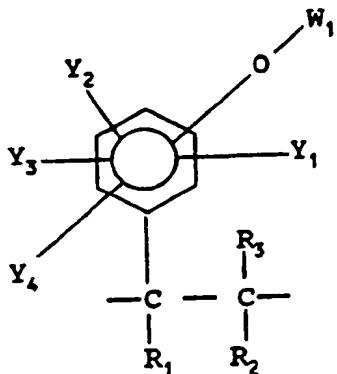
The triazoles are dissolved in water at levels of from about 0.1-5 grams/liter, preferably about 2-3 grams/liter and are employed in a working immersion bath in a concentration of about 25-5000 ppm, preferably about 500 to 2000 ppm. The pH of the triazole treating solutions as employed will be in the range of about 5-12 and will be adjusted conventionally by appropriate acid or base.

The triazoles ideally may be employed in admixture with certain polyphenol polymer compounds, earlier referred to herein and described in commonly assigned U.S. Patent 4,963,596 for use in a "post-treatment" of metal surfaces previously treated with a conversion coating composition. These polyphenol polymer compounds are described beginning at column 4, line 7 through column 7, line 52 of the 4,963,596 patent, which description is included below. The materials may generally be described as homo- or co-polymers of phenol compounds which contain a "Z" moiety as defined below and in which at least a portion of said "Z" moiety must contain a polyhydroxyalkyl amine functionality resulting from the condensation of an amine or NH₃ and a ketose, aldose or other alkyl aminopolyhydroxy compound having from about 3 to about 8 carbon atoms followed by reduction to an amine.

Polymer Material (a)

In accordance with the present invention a polymer useful in metal treatment applications is selected from polymer Materials (a)-(d). Polymer Material (a) comprises a polymer material having at least one unit having the formula:

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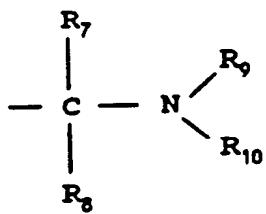
wherein:

10 R_1 through R_3 are independently selected for each of said units from the group consisting of hydrogen, an alkyl group having from 1 to about 5 carbon atoms, or an aryl group having about 6 to about 18 carbon atoms;

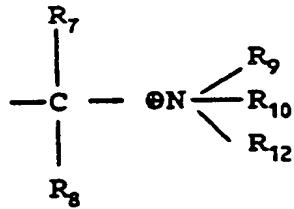
15 Y_1 through Y_4 are independently selected for each of said units from the group consisting of hydrogen, $-CR_1R_5OR_6$, $-CH_2Cl$, or an alkyl or aryl group having from 1 to 18 carbon atoms, or Z ;

 Z is

20



or



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however, at least a fraction of the Y_1 , Y_2 , Y_3 or Y_4 of the final compound or material must be Z and at least a fraction of said Z must contain a polyhydroxy alkylamine functionality resulting from the condensation of an amine or NH_3 and a ketose, aldose or other alkylaminopolyhydroxy compound having from about 3 to about 8 carbon atoms followed by reduction to an amine (from the imine);

30

R_5 through R_{12} are independently selected for each of said units from the group consisting of hydrogen, an alkyl, aryl, hydroxy-alkyl, amino-alkyl, mercapto-alkyl,

or phospho-alkyl moiety; R_{12} can also be $-O^{(-)}$ or $-OH$, in order to form an amine oxide or a hydroxyl amine;

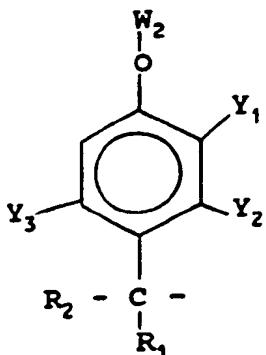
5 W_1 is independently selected for each of said units from the group consisting of hydrogen; an acyl moiety; an acetyl; a benzoyl moiety; 3-allyloxy-2-hydroxy-propyl-; 3-benzyloxy-2-hydroxy-propyl-; 3-alkylbenzyloxy-2-hydroxy-propyl-; 3-phenoxy-2-hydroxy-propyl-; 3-alkylphenoxy-2-hydroxy-propyl-; 3-butoxy-2-hydroxy-propyl; 3-alkyloxy-2-hydroxy-propyl; 2-hydroxyoctyl-; 2-hydroxy-alkyl-; 2-hydroxy-2-phenylethyl-; 2-hydroxy-2-alkyl phenyl ethyl-; benzyl-; methyl-; ethyl-; propyl-; alkyl-; allyl; alkyl benzyl-; haloalkyl-; haloalkenyl; 2-chloro-propenyl-; sodium, potassium; tetra aryl ammonium; tetra alkyl ammonium; tetra alkyl phosphonium; tetra aryl phosphonium; 15 or a condensation product of ethylene oxide, propylene oxide, a mixture, or copolymer thereof;

20 Preferred final materials are based on a vinyl phenolic moiety or methyl vinyl phenolic moiety. For example, vinyl phenol or isopropenyl phenol and derivatives thereof may be used.

25 It will be appreciated that the depiction above represents a repeating unit that characterizes the compound or materials of the present invention; no terminating end units are depicted. The end group not depicted of the polymers of the present invention can be selected by the skilled artisan relying upon art-disclosed techniques. For example, the end groups of the polymer may be either those resulting from the specific polymerization process employed or those intentionally 30 added to alter the polymer characteristics. For example, the end groups may be hydrogen, hydroxyl, initiation fragments, chain transfer agents, disproportionation groups, or other groups resulting from similar methods of terminating a growing polymer chain.

35 **Polymer Material (b)**

Polymer Material (b) comprises a polymer material having at least one unit having the formula:

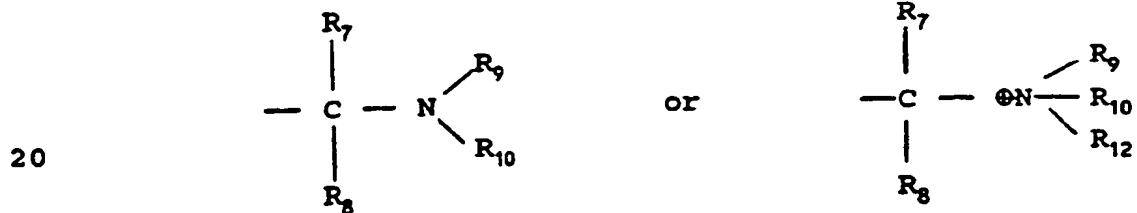


wherein:

10 R_1 through R_2 are independently selected for each of said units from the group consisting of hydrogen, an alkyl group having from 1 to about 5 carbon atoms, or an aryl group having from about 6 to about 18 carbon atoms;

15 Y_1 through Y_3 are independently selected for each of said units from the group consisting of hydrogen, $-CR_4R_5OR_6$, $-CH_2Cl$, an alkyl or aryl group having from 1 to 18 carbon atoms, or Z ,

Z is



25 but at least a fraction of the Y_1 , Y_2 or Y_3 of the final compound must be Z , and at least a fraction of said Z must contain a polyhydroxy alkyl-amine functionality resulting from the condensation of an amine or NH_3 and a ketose, aldose or other alkylaminopolyhydroxy compound having from about 3 to about 8 carbon atoms;

30 R_4 through R_{12} are independently selected for each of said units from the group consisting of hydrogen, or an alkyl, aryl, hydroxy-alkyl, amino-alkyl, mercapto-alkyl or phospho-alkyl moiety; R_{12} may also be $O^{(-)}$ or $-OH$ in order to form an amine or a hydroxyl amine;

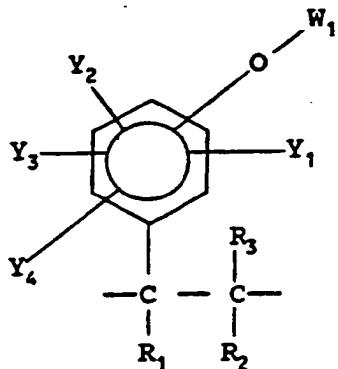
W_2 is independently selected for each of said units

from the group consisting of hydrogen; an acyl moiety; acetyl; benzoyl; 3-allyloxy-2-hydroxy-propyl-; 3-benzyloxy-2-hydroxy-propyl-; 3-alkylbenzyloxy-2-hydroxy-propyl-; 3-phenoxy-2-hydroxy-propyl-; 3-alkylphenoxy-2-hydroxy-propyl-; 3-butoxy-2-hydroxy-propyl-; 3-alkyloxy-2-hydroxy-propyl-; 2-hydroxyoctyl-; 2-hydroxy-alkyl-; 2-hydroxy-2-phenyl-ethyl-; 2-hydroxy-2-alkyl-phenylethyl-; benzyl-; methyl-; ethyl-; propyl-; alkyl; allyl-; alkylbenzyl-; haloalkyl-; haloalkenyl; 2-chloro-propynyl-; or a condensation product of ethylene oxide, propylene oxide, a mixture, or copolymer thereof;

Polymer Material (c)

Polymer Material (c) comprises a co-polymer material wherein at least one portion of said co-polymer has the structure:

20



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and at least a fraction of said portion is polymerized with one or more monomers having a $C=C$ moiety. Useful monomers include those independently selected for each of said units from the group consisting of acrylonitrile, methacrylonitrile, methyl acrylate, methyl methacrylate, vinyl acetate, vinyl methyl ketone, isopropenyl methyl ketone, acrylic acid, methacrylic acid, acrylamide, methacrylamide, n-amyl methacrylate, styrene, m-bromostyrene, p-bromostyrene, pyridine, diallyl-dimethylammonium salts, 1,3-butadiene, n-butyl acrylate, tert-butylamino-ethyl methacrylate, n-butyl methacrylate, tert-butyl methacrylate, n-butyl vinyl ether, tert-butyl vinyl ether, m-chlorostyrene, o-chlorostyrene, p-

chlorostyrene, n-decyl α -thacrylate, N,N-diallylmelamine, N,N-di-n-butylacrylamide, di-n-butyl itaconate, di-n-butyl maleate, diethylaminoethyl methacrylate, diethyleneglycol monovinyl ether, diethyl fumarate, diethyl itaconate, 5 diethyl vinylphosphonate, vinylphosphonic acid, diisobutyl maleate, disopropylitaconate, disopropyl maleate, dimethyl fumarate, dimethyl itaconate, dimethyl maleate, di-n-nonyl fumarate, di-n-nonyl maleate, dioctyl fumarate, di-n-octyl itaconate, di-n-propyl itaconate, n-dodecyl vinyl ether, ethyl acid fumarate, ethyl acid maleate, ethyl acrylate, ethyl cinnamate, N-ethylmethacrylamide, ethyl methacrylate, ethyl vinyl ether, 5-ethyl-2-vinylpyridine, 5-ethyl-2-vinylpyridine 1-oxide, glycidyl acrylate, glycidyl methacrylate, n-hexyl methacrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, isobutyl methacrylate, isobutyl vinyl ether, isoprene, isopropyl methacrylate, isopropyl vinyl ether, itaconic acid, lauryl methacrylate, methacrylamide, methacrylic acid, methacrylonitrile, N-methylolacrylamide, N-methylolmethacrylamide, N-isobutoxymethylacrylamide, N-isobutoxymethylacrylamide, N-alkyloxymethylacrylamide, N-vinyl-caprolactam, methyl acrylate, N-methylmethacrylamide, α -methylstyrene α -acrylate, N-methylstyrene, o-methylstyrene, p-methylstyrene, 2-methyl-5-vinylpyridine, n-propyl methacrylate, sodium p-styrenesulfonate, stearyl methacrylate, styrene, p-styrenesulfonic acid, p-styrenesulfonamide, vinyl bromide, 9-vinylcarbazole, vinyl chloride, vinylidene chloride, 1-vinylnaphthalene, 2-vinylnaphthalene, 2-vinylpyridine, 4-vinylpyridine, 2-vinylpyridine N-oxide, 4-vinylpyrimidine, N-vinylpyrrolidone; and W_1 , Y_1-Y_4 and R_{1-12} are as in (a), above.

Within such materials, the ratio of any single monomer to any other monomer can be about 1:99 to about 99:1, preferably about 5:1 to about 1:5, and more preferably 1.5:1 to about 1:1.5.

Polymer Material (d) - Condensate polymers

By the term "condensation polymers" is meant the following:

5 A condensation polymer of polymer materials (a), (b), or (c), wherein condensable forms (i.e., modified as noted below) of (a), (b), or (c), or mixtures thereof, is condensed with a second compound selected from the group consisting of phenols (preferably phenol, alkylphenol, 10 arylphenol, cresol, resorcinol catechol, pyrogallol), tannins, (both hydrolyzable and condensed) novolak resins, lignin compounds, together with aldehydes, ketones or mixtures thereof, to produce a condensation resin product, 15 that is a prepolymer of Polymer Material (d). This condensation resin prepolymer product is then further reacted by the addition of "Z" to at least a portion of it by reacting said resin prepolymer product with an aldehyde or ketone and a secondary amine producing a final adduct which can react with an acid and/or can be reacted with 20 hydrogen peroxide to generate an amine oxide. The amine oxide can then be acid neutralized to form the hydroxyl amine if desired.

While this condensation product is described for convenience as being prepared by a sequential reaction, it will be appreciated that these materials can be prepared 25 by carrying out the necessary steps in any order, or simultaneously. However, the sequence described is preferred.

It is appreciated by those skilled in the art, that the alkenylphenolic moieties of the present invention can be either randomly distributed within the copolymer and terpolymer or can be synthesized to constitute a block orientated polymer, depending upon the methods and 30 conditions used for polymerization.

Preferr d aldoses, ketoses, and derivatives for use 35 in the ab ve materials include, without limitation, glucose, fructose, alditols such as mannitol, arabinose, mannose, ribose, ribitol, and the like. Acids such as

aldonic and aldaric acids may also be employed. Disaccharides and polysaccharides that can be easily hydrolyzed under reaction conditions to one or more of the useful aldoses and ketoses may also be employed.

5 As disclosed in U.S. Patent 4,963,596 the polyphenol compounds thereof were useful in the "post-treatment" of already conversion coated metal surfaces. It was discovered that the polyphenol compounds of the patent, described above, may also be employed alone in the post 10 treatment of non-conversion coated metal surfaces. The polyphenol compounds are particularly effective as a post-treatment coating in sealing tubular core structure, non-conversion coatings, which were described earlier. Thus, while the patent teaches only the post-treatment by the 15 polyphenol compounds for conversion coating, which were reactive with the metal surface, the present invention provides post-treatment of other coatings provided such previously applied protective coating has a porous tubular structure. The polyphenol polymer material, providing it 20 contains the amine functionality through the "Z" moiety or defined, provides for greatly improved corrosion resistance and adhesion properties for any subsequent decorative or protective coatings. In the Z moiety defined earlier, R₉ is preferably an hydroxyethyl or 25 glucose group and R₁₀ is preferably methyl with the remaining groups R₇ - R₁₂ being hydrogen. The polymer is employed in an aqueous solution which will vary in pH from about 0.5 to about 14, preferably about 3-12.

30 In each of the treatment compositions of the present invention, the composition comprises an effective amount of the treatment compound dissolved or dispersed in a carrier suitable for surface treatment of the previously 35 coated metal surface. Generally, the carrier is water in which the active treatment compounds are soluble or dispersible. However, small amounts of polar organic solvents, such as an alcohol and/or glycols including glycol ethers, may be employed to promote solubility and

dispersibility.

Ideally, the post-treatment with composition is carried out immediately after the initial protective coating is formed on the metal surface and no drying step is required after the first coating is applied. The seal coating accordingly proceeds without delay after rinsing which follows the initial coating step. Following directly after the first coating application eliminates any drying step of the first coating or any further rinsing or cleaning of the first coating application. The method or process of coating in the present invention accordingly comprises contacting a metal surface having a protective coating thereon with a liquid composition comprising at least one of the compositions of this invention as described above, thereby sealing said initial protective coating and providing improved corrosion resistance. After application of the seal coating composition, the surface is preferably rinsed before drying, however, good results can be obtained without rinsing for many end uses. While room temperature drying can be employed, use of elevated temperatures up to about 450°F, with temperatures up to about 200°F preferred for aluminum and similar metals, is preferred to decrease the amount of drying time required.

The thickness of the final dry coating, including the initial coating on the metal surface will depend on its purpose or functions and will typically range from about 0.0001 mil to about 0.05 mil, preferably 0.0001 to about 0.01 mil. Additional cleaning or rinsing step is required before the seal coating treatment of the present invention.

In the seal treatment, the solution can vary over a relatively wide range of concentration. Useful levels will range from about 0.001% by weight up to about 10%, and more preferably up to about 5%. Practically speaking concentrations of about 0.001% to about 1-2% are preferred.

As noted earlier, the seal treatment can be applied by any conventional manner including immersion or dipping, spray coating, roller coating, wipe or brush, thixotropic or non-thixotropic, viscous or non-viscous and the like.

5 The temperature of the solution applied can vary over a wide range, but is preferably from about 70°F to about 220°F. In an immersion application times of from about 5 to about 30 minutes will generally be adequate. The time of application can be reduced substantially however by 10 other application methods, such as spray coating.

Further understanding of the present invention, can be had from the following examples. As used herein "salt spray" refers to salt spray corrosion resistance measured in accordance with ASTM-B-117-61. In reporting the 15 results, the numerical rating of 10 would indicate no pits in the surface while a rating of 9 indicates up to about 2 pits, while a rating of 5 indicates about 20-30 pits. A rating of 0 would indicate pits of about 100 upwards.

Example

20 In order to illustrate and evaluate the improved corrosion resistance employing the seal coating compositions of the present invention, 3 inch by 5 inch samples of 2024 T3 aluminum alloy, .032 inch thickness, coated with a chromate-free conversion coating were coated 25 with the seal coating compositions of the present invention as described below in more detail. The starting samples were prepared by conventional means including degreasing, cleaning, etching and deoxidizing, desmutting, rinsing and a non-chromate containing coating 30 applied by immersion for 30 minutes at about 125°F followed by an immersion rinse at 140°F for 5 minutes. The samples were then seal coated by immersion in the aqueous solution of the present invention for 15 minutes at 180°F followed by an immersion rinse in tap water for 3 minutes 35 at ambient temperature. The samples were then air dried at ambient temperature.

The samples were then tested for salt spray

resistance in accordanc with ASTM-B-117-61 with th results noted below. The seal formulations employed as aqueous solutions were as follows:

Formulation A (inorganic):

5	<u>Component</u>	<u>Concentration (g/l)</u>
	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	8
	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$	8
	H_3BO_3	20
	NH_4NO_3	16

Formulation B (inorganic):

10	<u>Component</u>	<u>Concentration (g/l)</u>
	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	8
	$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	8
	H_3BO_3	20
15	NH_4NO_3	16

Formulations A and B, having initial pH values of 3.4 and 4.0 respectively, were then each adjusted with potassium hydroxide to a pH of 5.5.

20 Formulation C, an organic formulation, was an aqueous solution of a commercially available triazole, COBRATEC 725 in a concentration of 2 grams/liter, which provided a solution at a pH of 9.5.

25 Formulation D, an organic polymer, a poly (vinylphenol), was prepared as an aqueous solution of the polymer in water at a concentration of 2% by weight, which had a pH of 6.7. The polymer was Parcolene® 95AT of Parker+Amchem Division of Henkel Corporation, a methyl glucamine derivative of a poly (vinylphenol) resin (Resin M obtained from Maruzen Oil having a molecular weight of about 5000).

30 The results of the ASTM salt spray test can be seen from Table I below, the ratings being an average of testing of 10 panels in accordanc with the ASTM method.

Table I
Salt Spray Results (168 Hrs.)

<u>Formulation</u>	<u>Rating</u>	<u>No. of Pits</u>
5	A	9 0-2
	B	9 0-2
	C	10 0
	D	10 0
None (no seal coat)	0	> 100

The foregoing illustrate the improved corrosion
10 resistance by the seal coatings of the present invention.
Photomicrographs (10,000X and 50,000X) of the panels
containing the chromate-free protective coating before
sealing reveal a tubular pore structure in which the cells
15 containing the pores are of circular or oval cross
section, extending upwardly from the aluminum surface, the
bottom of cells forming a barrier layer above the surface
of the aluminum. As can be seen from the results above,
this barrier layer is insufficient to provide significant
20 corrosion resistance, the panels without any seal coat
failing within 168 hours having a rating of 0 (>100 pits).
In contrast, the panels containing the same initial
chromate-free coating, when sealed with the compositions
25 of the present invention, provided significant resistance
to corrosion showing virtually no pits for coatings on the
order of 9-10, after exposure to 168 hours.

As can be seen from the foregoing, seal coating
formulations are provided for a wide range of pH levels
and the optimum pH levels will vary for the specific
formulations. The inorganic formulations above are
30 particularly pH dependent and generally provide the most
desirable results at pH levels above 4 to about 7, i.e.
4.5 to 7, with optimum results generally within a pH range
of about 5-6. The organic compositions are somewhat less
pH dependent and vary over a wide pH range of application,
35 particularly the polymer type which may be applied in the

range of preferably about 3-12, with the more desired results generally in the pH range of about 6-10.

While the triazole coating was exemplified with COBRATEC 725, the other available COBRATEC products, 5 TT-100 (tolyltriazole) and 99 (benzotriazole) and mixtures of tolyltriazole and benzotriazole will provide substantially similar results. Mixture of the triazole products and polymer, which may be applied within the pH range of 4-12, may provide for the desirable properties of 10 each of the organic seal coatings.

What is claimed is:

1. A coating composition, effective in forming a seal coating for a previously applied protective coating on a metal surface, comprising an aqueous solution of components selected from the group consisting of:

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- (A) (1) nickel sulfate
- (2) manganese sulfate
- (3) boric acid or borate thereof
- (4) ammonium nitrate;

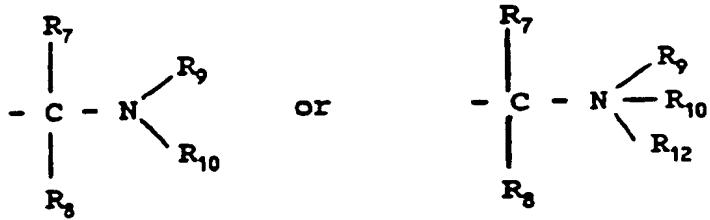
10 (B) (1) nickel sulfate

- (2) cobalt nitrate
- (3) boric acid or borate thereof
- (4) ammonium nitrate;

15 (C) an azole;

(D) a poly (vinylphenol) polymer having a Z moiety of the formula

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where R_7 through R_{12} are independently selected from the group consisting of hydrogen, an alkyl, aryl, hydroxy-alkyl, amino-alkyl, mercapto-alkyl or phospho-alkyl moiety and R_{12} can also be $-O^{(-)}$ or $-OH$, in order to form an amine oxide or hydroxyl amine; and

(E) and mixtures of any two or more of (A), (B), (C) and (D)

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and further provided that when (D) above is employed alone, said previously applied protective coating is a non-conversion coating; and said aqueous solutions (A)

through (E) contain amounts effective to increase the corrosion resistance of the seal coated metal surface over that afforded only by said previously applied protective coating.

- 5 2. A coating composition as defined in claim 1 wherein the pH of aqueous solutions (A) and (B) is in the range of about 4.5 to 7.
- 3. A coating composition as defined in claim 2 wherein the pH is in the range of 5-6.
- 10 4. A coating composition as defined in claim 1 wherein the total amount of nickel sulfate and manganese sulfate in (A) and the total amount of nickel sulfate and cobalt nitrate in (B) is in the range of about 12-20 grams per liter and the ratio by weight of the nickel sulfate to manganese sulfate in (A) and to the cobalt nitrate in (B) is in the range of about 1:5 to 5:1.
- 15 5. A coating composition as defined in claim 4, wherein the ammonium nitrate is present in an amount of about 10 to about 30 grams per liter.
- 20 6. A coating composition as defined in claim 5, wherein boric acid is employed in an amount of about 15 to about 25 grams per liter.
- 25 7. A composition as defined in claim 1 wherein aqueous solution (A) has the composition

	<u>Component</u>	<u>grams/liter</u>
	<chem>NiSO4 · 6H2O</chem>	8
	<chem>MnSO4 · H2O</chem>	8
	<chem>H3BO3</chem>	20
30	<chem>NH4NO3</chem>	16

and composition (B) has the composition

	<u>Component</u>	<u>grams/liter</u>
	<chem>NiSO4 · 6H2O</chem>	8
	<chem>Co(NO3)2 · 6H2O</chem>	8
35	<chem>H3BO3</chem>	20
	<chem>NH4NO3</chem>	16

8. A composition as defined in claim 1 wherein said azol is an aliphatic or aromatic triazole having up to 18 carbon atoms.
9. A composition as defined in claim 8 wherein said triazole is selected from the group consisting of benzotriazole, tolyltriazole and methyltriazole.
- 5 10. A composition as defined in claim 8 wherein said triazole is present in said solution in an amount up to 5 grams per liter.
- 10 11. A composition as defined in claim 10 wherein said triazole is present in an amount of about 2 to 3 grams per liter.
12. A metal article having a metal surface coated with a previously formed protective coating comprising a seal coating over said previously formed coating, said seal coating having the components defined in claim 1.
- 15 13. A metal article as defined in claim 12 wherein said metal is selected from the group consisting of aluminum, iron, steel, zinc, copper and magnesium.
- 20 14. A metal article as defined in claim 12 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a conversion coating.
- 25 15. A metal article as defined in claim 12 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a non-conversion coating.
- 30 16. A metal article as defined in claim 12 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a coating having a cell and pore structure.
17. A metal article as defined in claim 16 wherein said cell and pore structure is tubular having substantially circular or oval shape cell wall structure.
- 35 18. A metal article as defined in claim 17 wherein said seal coating consists essentially of component

composition (D).

5 19. A metal article having a metal surface coated with a previously formed protective coating thereon, comprising a seal coating over said previously formed protective coating, said seal coating comprising the component composition defined in claim 7.

10 20. A metal article as defined in claim 19 wherein said metal is aluminum or an alloy thereof.

10 21. A metal article having a metal surface coated with a previously formed protective coating thereon, comprising a seal coating over said previously formed protective coating, said seal coating comprising the component composition defined in claim 8.

15 22. A process for improving the protection of a metal surface having a previously formed protective coating thereon, comprising applying a seal coating composition over said previously formed protective coating by contacting said metal surface with an aqueous solution of the seal coating component composition defined in claim 1.

20 23. A process as defined in claim 22, and further comprising rinsing the metal surface containing the seal coating and drying the coating thereby providing a coated metal surface having improved protection against corrosion.

25 24. A process as defined in claim 22 wherein said metal surface is aluminum or an alloy thereof.

25 25. A process as defined in claim 22 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a coating having a cell and pore structure.

30 26. A process as defined in claim 22 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a conversion coating.

35 27. A process as defined in claim 22 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a non-conversion coating.

28. A process as defined in claim 22 wherein said metal is aluminum or an alloy thereof and said previously formed protective coating is a chromate-free coating.

29. A process for improving the protection of a metal surface having a previously formed protective coating thereon, comprising applying a seal coating composition over said previously formed protective coating by contacting said metal surface with an aqueous solution of the seal coating component composition defined in claim 7.

10 30. A process for improving the protection of a metal surface having a previously formed protective coating thereon, comprising applying a seal coating composition over said previously formed protective coating by contacting said metal surface with an aqueous solution of the seal coating component composition defined in claim 8.

15 31. In a process for the formation of an improved corrosion resistant coating onto an aluminum surface wherein said aluminum surface has a previously formed protective coating on said metal surface, and wherein a seal coating is applied over said previously formed protective coating and subsequently rinsed and dried, the improvement which comprises applying to said previously formed protective coating on said aluminum surface the seal coating composition as defined in claim 7.

20 32. In a process for the formation of an improved corrosion resistant coating onto an aluminum surface wherein said aluminum surface has a previously formed protective coating on said metal surface, and wherein a seal coating is applied over said previously formed protective coating and subsequently rinsed and dried, the improvement which comprises applying to said previously formed protective coating on said aluminum surface the seal coating composition as defined in claim 8.

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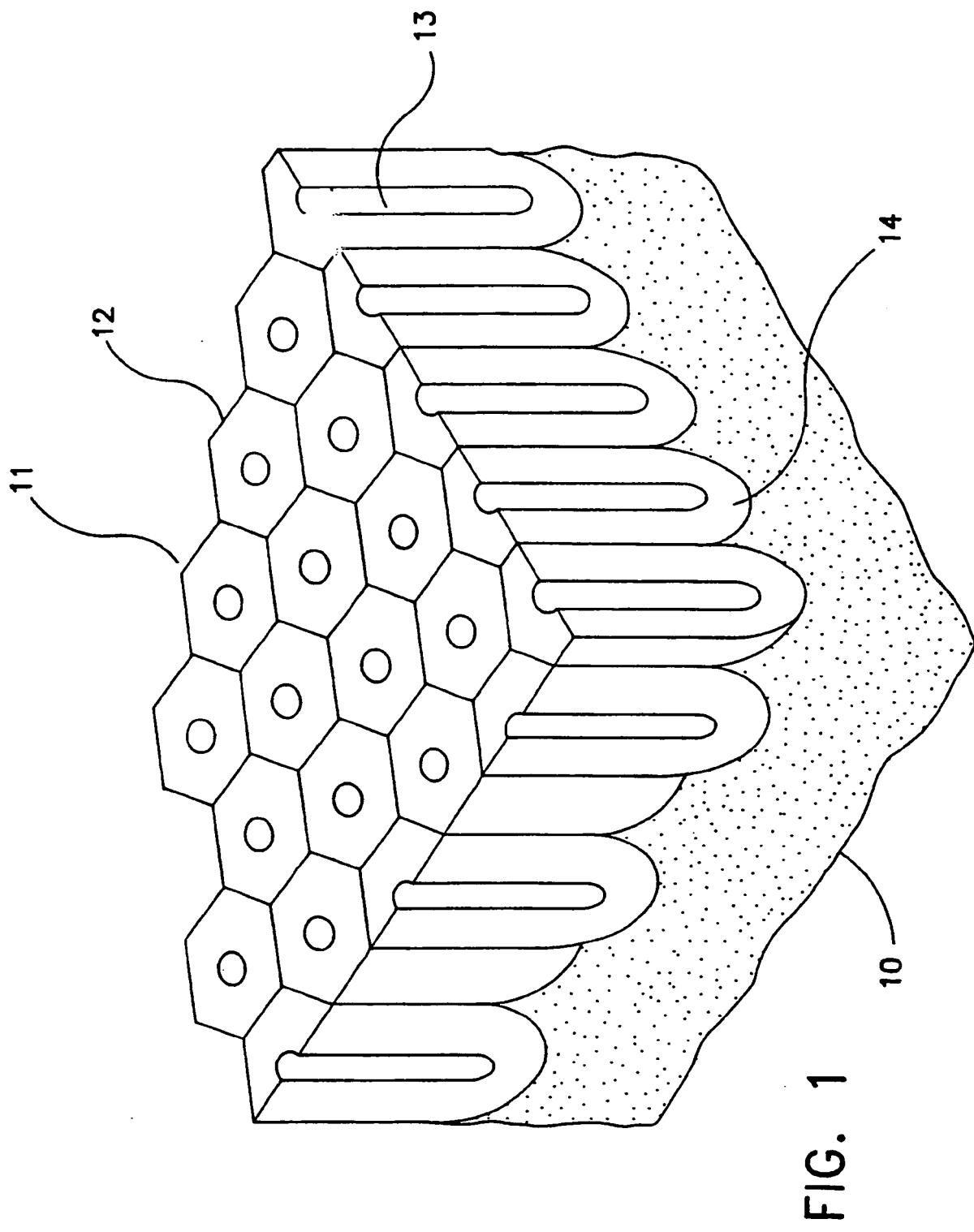


FIG. 1

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

PCT/US 92/02773

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 C23C22/83; C25D11/24

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System	Classification Symbols
Int.Cl. 5	C23C ; C25D

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched⁸III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	CHEMICAL ABSTRACTS, vol. 113, no. 16, 15 October 1990, Columbus, Ohio, US; abstract no. 136940R, TOYOSE, KIKURO: 'coated aluminum or its alloy sheets for heat-exchanger fins' page 296 ; see abstract ---	1,12-14, 22-24,26
X	EP,A,0 091 166 (SOCIETE CONTINENTALE PARKER) 12 October 1983 see page 4, paragraph 2; claims 1,2 see page 5, paragraph 1 ---	1,12,13
A	EP,A,0 127 774 (ALVAREZ SANCHIS) 12 December 1984 see claims 1-4; examples 2-3 ---	1-4 -/-

¹⁰ Special categories of cited documents :

- ¹¹ "A" document defining the general state of the art which is not considered to be of particular relevance
- ¹² "E" earlier document but published on or after the international filing date
- ¹³ "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- ¹⁴ "O" document referring to an oral disclosure, use, exhibition or other means
- ¹⁵ "P" document published prior to the international filing date but later than the priority date claimed

¹⁶ "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention¹⁷ "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step¹⁸ "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art¹⁹ "&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

22 SEPTEMBER 1992

Date of Mailing of this International Search Report

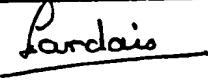
30. 09. 92

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

LANDAIS A.M.



III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	EP,A,0 149 720 (GERHARD COLLARDIN GMBH) 31 July 1985 see claims 1,3-5; table 1 ---	1,22-24
A	CHEMICAL ABSTRACTS, vol. 87, no. 20, 14 November 1977, Columbus, Ohio, US; abstract no. 159140P, KUMAZAKA, IMIO: 'anodized aluminum sealing solutions' page 458 ; see abstract ----	1,12,13, 16,17

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. US 9202773
SA 60267

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 22/09/92

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